

# THE NORTH-SOUTH TRANSITION OF FLORA ACROSS ARKANSAS: A PRELIMINARY PHYTOGEOGRAPHICAL ANALYSIS

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## ABSTRACT

Biogeographers have divided Arkansas into physiogeographic provinces and ecoregions. Using quantitative methods, we examined the north-south floristic transition across Arkansas to see if phyto-geographic regions are detectable by abrupt changes in the flora. We found only gradual change even though there are abrupt and major physiographical discontinuities.

## RESUMEN

Los biogeógrafos han dividido Arkansas en provincias fisiogeográficas y ecorregiones. Usando métodos cuantitativos, examinamos las transiciones norte-sur a través de Arkansas para ver si las regiones fitogeográficas son detectables por cambios abruptos en la flora. Hemos encontrado sólo cambio gradual aunque hay discontinuidades fisiográficas abruptas y mayores.

## INTRODUCTION

Virtually all physiogeographic and ecoregional mappers treat the Interior Highlands of Arkansas, Illinois, Kansas, Missouri, and Oklahoma as being distinct from surrounding areas. While most appear to agree on a physiogeographic map, they present conflicting interpretations of the biotic provinces and ecoregions (e.g., Dice 1943; Braun 1950; Gleason & Cronquist 1964; Kuchler 1964; Foti 1974; Pell 1983; Omernik 1986; Takhtajan 1986; Thorne 1993; Bailey et al. 1994; Keys et al. 1995; Weakley et al. 1998; Foti & Bukenhofer 1998; Ricketts 1999). For example, Dice (1943), Takhtajan (1986), and Thorne (1993) consider the Interior Highlands and Gulf Coastal Plain to be different provinces, Bailey et al. (1994) and Keys et al. (1995) break the Interior Highlands into two provinces, Omernik (1986) divides the area into six ecoregions, and Weakley et al. (1998) divide it into four ecoregions.

While it is unquestionably the case that the Ouachita Mountains and the Ozark Plateau are physiogeographically distinct from surrounding areas, notably the West Gulf Coastal Plain to the south, it is not so certain that the area is particularly distinct floristically. Zollner et al. (2005:1788), speaking of the In-

terior Highlands in general, question its uniqueness: “for all of its physiographic uniqueness, including age, long-term isolation from its moiety—the Appalachian region—, and its reputation as a ‘well-known refugium’ (Meyer 1997:364) [the Interior Highlands] shows surprisingly little floristic unicity from surrounding regions.” This was also recognized years ago by Palmer (1921) when he pointed out that about 90 percent of the woody flora of the Ozark region also occurs in the Gulf Coastal Plain.

This point was brought home to us forcefully when we conducted a floristic inventory of the Ouachita Mountains Biological Station in Polk County, Arkansas (MacRoberts et al. 2005). Having extensive experience with the flora of the West Gulf Coastal Plain, but none with the Ouachita Mountains, we expected, since the physiogeography was so different and since biogeographers have separated the Interior Highlands from the Coastal Plain, that the two areas would be quite floristically distinct. Surprisingly they are not. The flora of the Ouachita Mountains Biological Station presented some species unknown to us, but not many.

In a previous paper, we documented the east-west floristic transition across central Texas in which the eastern flora precipitously drops out and is replaced by a western flora and vice versa (MacRoberts & MacRoberts 2003). In this study, using similar methods we examine the north-south floristic transition across Arkansas, i.e., from the West Gulf Coastal Plain in the south into the Interior Highlands in the north (Fig. 1). Western Louisiana and southern Arkansas are physiographically the Gulf Coastal Plain (Fenneman 1938; Brouillet & Whetstone 1993) and the Atlantic and Gulf Coastal Plain floristic province (Takhtajan 1986; Thorne 1993). The Interior Highlands, on the other hand, are part of the Ozark and Ouachita physiographic region (Fenneman 1938; Brouillet & Whetstone 1993) and the Appalachian floristic province (Takhtajan 1986; Thorne 1993).

The purpose of this paper is to provide data on 1) how different floristically the Interior Highlands is from the West Gulf Coastal Plain, 2) the effect of the physiogeographic differences on the north-south floristic transition of flora from the Coastal Plain into the Interior Highlands, and 3) the floristic relationship between the Interior Highlands and the regions that surround it.

#### STUDY SITES

The Interior Highlands and the Gulf Coastal Plain have been described in numerous publications (Fenneman 1938; Foti 1974; Pell 1983; Bryant et al. 1993; Skeen et al. 1993; Dale & Ware 1999; Delcourt & Delcourt 2000) and will not be redescribed here except to say that the former region consists of moderate elevation mountains of Paleozoic sedimentary rock with numerous swift clear streams and rivers and both deciduous and pine-hardwood forests; the latter region consists of low to gently rolling topography of Cretaceous and Tertiary silts and clays char-

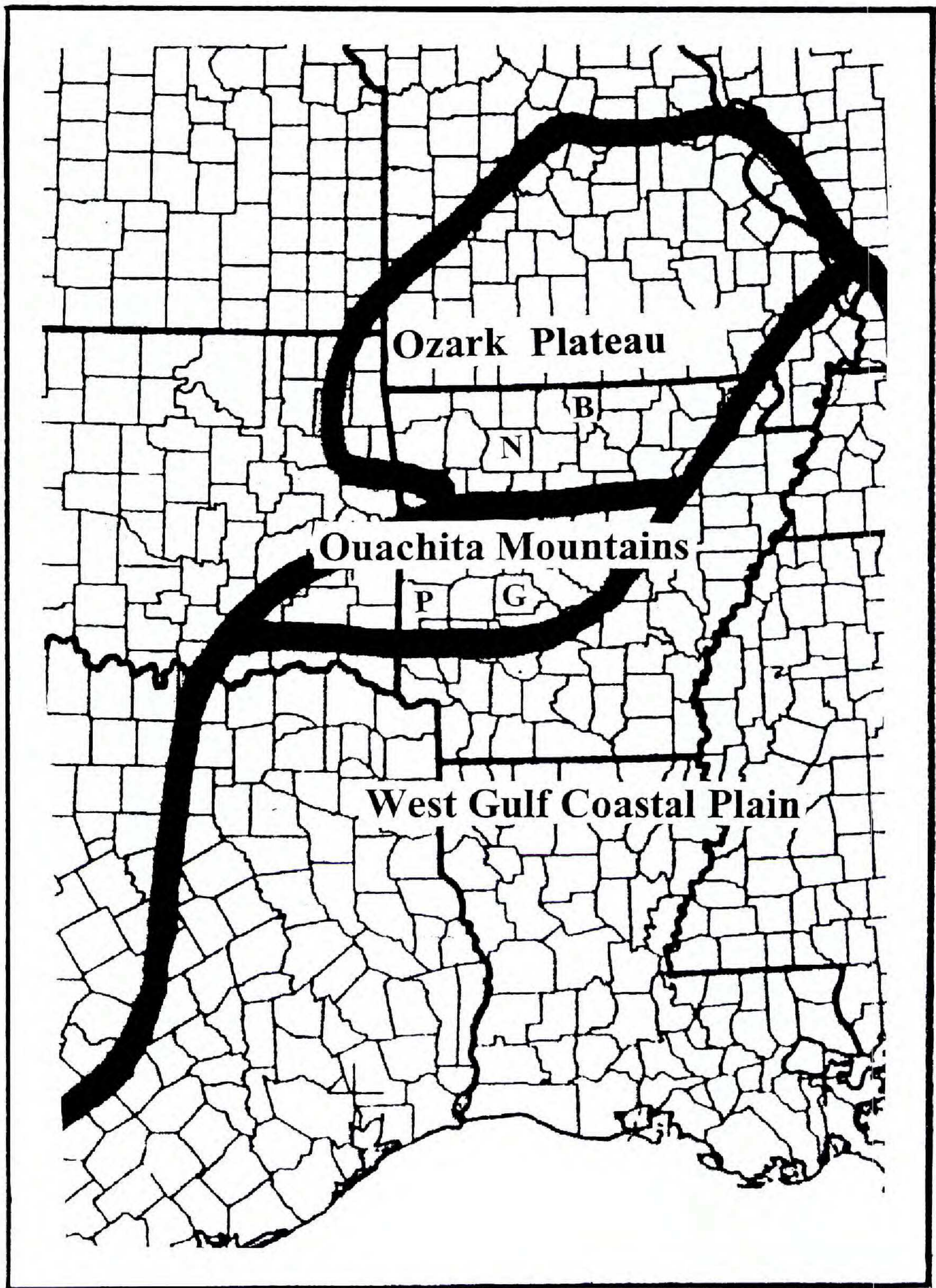


FIG. 1. Location of Interior Highlands and Gulf Coastal Plain showing location of Ouachita Mountains and Ozark Plateau and Baxter (B), Garland (G), Newton (N), and Polk (P) counties.

acterized by forests of pine and hardwoods, with swamps, and sluggish muddy streams and rivers, and oxbow lakes. Precipitation is about the same in both areas, with temperatures slightly cooler in the Interior Highlands.

#### METHODS

**1)** As we pointed out in the introduction, we have recently conducted a floristic survey of the 211 hectare Ouachita Mountains Biological Station in Polk County, Arkansas (MacRoberts et al. 2005). It is located 174 km north of Louisiana in the Ouachita Mountains and has an elevation range of between 395 and 622 meters. It is dominated by pine-hardwood forests on shale, chert, novaculite, siltstone, and sandstone. It could not be more different edaphically and topographically from the West Gulf Coastal Plain. We have documented 315 native species on the station. We compared this list to floristic lists for Louisiana (Thomas & Allen 1993–1998; Kartesz & Meacham 1999) to determine the percentage of species in common. While the Ouachita Mountains Biological Station is a very small area given the size and diversity of the Ouachita Mountains, it provided a first comparison of the flora between the West Gulf Coastal Plain and the Ouachita Mountains.

**2)** In order to obtain a more detailed understanding of the possible effect of the Interior Highlands on plant distribution, using the Thomas and Allen (1993–1998) atlas we randomly selected 254 native species occurring in northern Louisiana (north of T1N) that also occur in Arkansas (Smith 1988, 1994). Using Kartesz and Meacham (1999), we determined how many of these occur in Missouri, approximately 380 km to the north. The sample size is only about 10 percent of the native species but sufficient to compare the flora between the regions.

**3)** As an independent test of Method 2, using Hyatt (1993) we determined the percentage of native species occurring in Baxter County, Arkansas, on the Missouri border in the Ozark Plateau, that also occur in the Gulf Coastal Plain of Texas and Louisiana (Thomas & Allen 1993–1998; Kartesz & Meacham 1999; Turner et al. 2003). Naturally, some of the species in this sample are the same as those in Method 2.

**4)** Using the data in Method 2, we plotted the Arkansas county distribution of the 254 native species. Because all counties are not collected equally (e.g., Jackson County has 275 reported taxa while Washington County has 1,301 reported taxa), we expressed the results as percentages; that is, we divided the number of species in our sample reported for each county by the total species reported for each county. Thus, of the 254 species in the sample, 99 are reported for Miller County, and Smith (1988) reports 544 species for Miller County ( $99/544 = 18\%$ ).

**5)** Having found that Method 4 did not reveal sharp distributional discontinuities in the flora across Arkansas (see “Results”), using Kartesz and

Meacham (1999) we surveyed the entire flora of North America and found all of the native species that were reported to occur in Missouri and Arkansas (but not in Louisiana) and in Louisiana and Arkansas (but not in Missouri) irrespective of where else they occurred. Using Smith (1988), we then plotted these species by Arkansas counties according to whether they were Missouri/Arkansas species or Louisiana/Arkansas species (i.e., coming from the north or the south). Our sample consisted of 499 species: 272 Missouri/Arkansas and 227 Louisiana/Arkansas. Our numerical procedure was the same as in Method 4. Our hope was to magnify the curve by eliminating species that occurred in all three states.

**6)** In order to determine the overall North American floristic association of the Interior Highlands, using Smith (1988) we randomly selected 296 native species from Garland County, Arkansas, which is entirely within the Ouachita Mountain region, and 293 native species from Newton County, Arkansas, which is entirely within the Ozark Plateau region (both counties being well collected) and, using Kartesz and Meacham (1999), plotted their state/regional occurrence expressed as percentage of species in common.

All of these measures are of presence/absence, not abundance. The data necessary to investigate abundance are not yet available on a large scale. Thus, we recognize that some taxa may be widely distributed across the region while others may not. Also, while we recognize the limitation of the main data sources for this paper, we have made every effort to adjust to those limitations. But since the study is a preliminary analysis, it can absorb some error without compromising the general conclusions. The paper provides a problem and an analysis that should be followed up by a more extensive sample of species and more points along the continuum.

## RESULTS

**1)** Of the 315 species on our Ouachita Mountain Biological Station list, 287 or 91% occur in Louisiana entirely within the West Gulf Coastal Plain.

**2)** Of the 254 species in our north Louisiana sample, 209 or 82% reached Missouri and 45 or 18% stopped in Arkansas.

**3)** Eighty-two percent of the native species that occur in Baxter County on the Missouri border also occur in the West Gulf Coastal Plain of Louisiana and Texas.

**4)** Figure 2 summarizes the results of Method 4. Counties on the southern tier of Arkansas averaged around 18% and 19% of the sample, and counties on the northern tier averaged between 12% and 16% of the sample. No marked or abrupt shifts in flora were detected that correlated with the natural physiogeographic divisions of Arkansas.

**5)** Figure 3 summarizes the results of Method 5. No marked or abrupt shifts in flora were detected that correlated with the natural physiogeographic divisions of Arkansas.

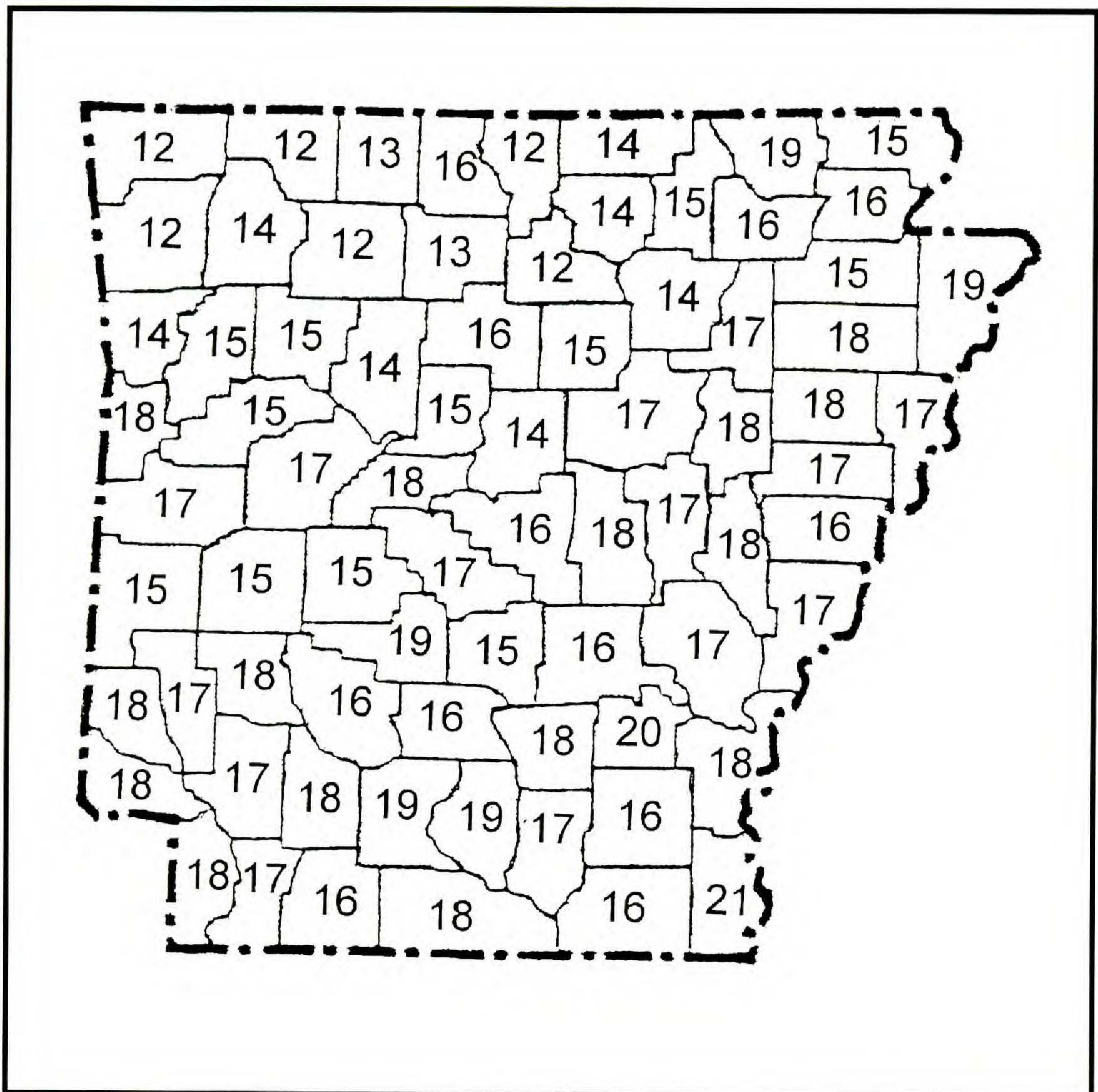


FIG. 2. Percent occurrence by county of 254 Louisiana species (see text for further explanation).

6) Figure 4 shows that the Ouachita Mountains has about 91% of its flora in common with the West Gulf Coastal Plain and the Ozark Plateau has about 82% of its flora in common with the West Gulf Coastal Plain. It also shows that the Ouachita and Ozark mountain/plateau regions are not only continuous floristically with the surrounding regions but virtually indistinguishable from them.

#### DISCUSSION

As noted in the introduction, biogeographers have presented a number of schemes for subdividing the Interior Highlands. These range from putting the Interior Highlands and Gulf Coastal Plain into separate biotic provinces or ecoregions to dividing the Interior Highlands into two provinces, and so on.

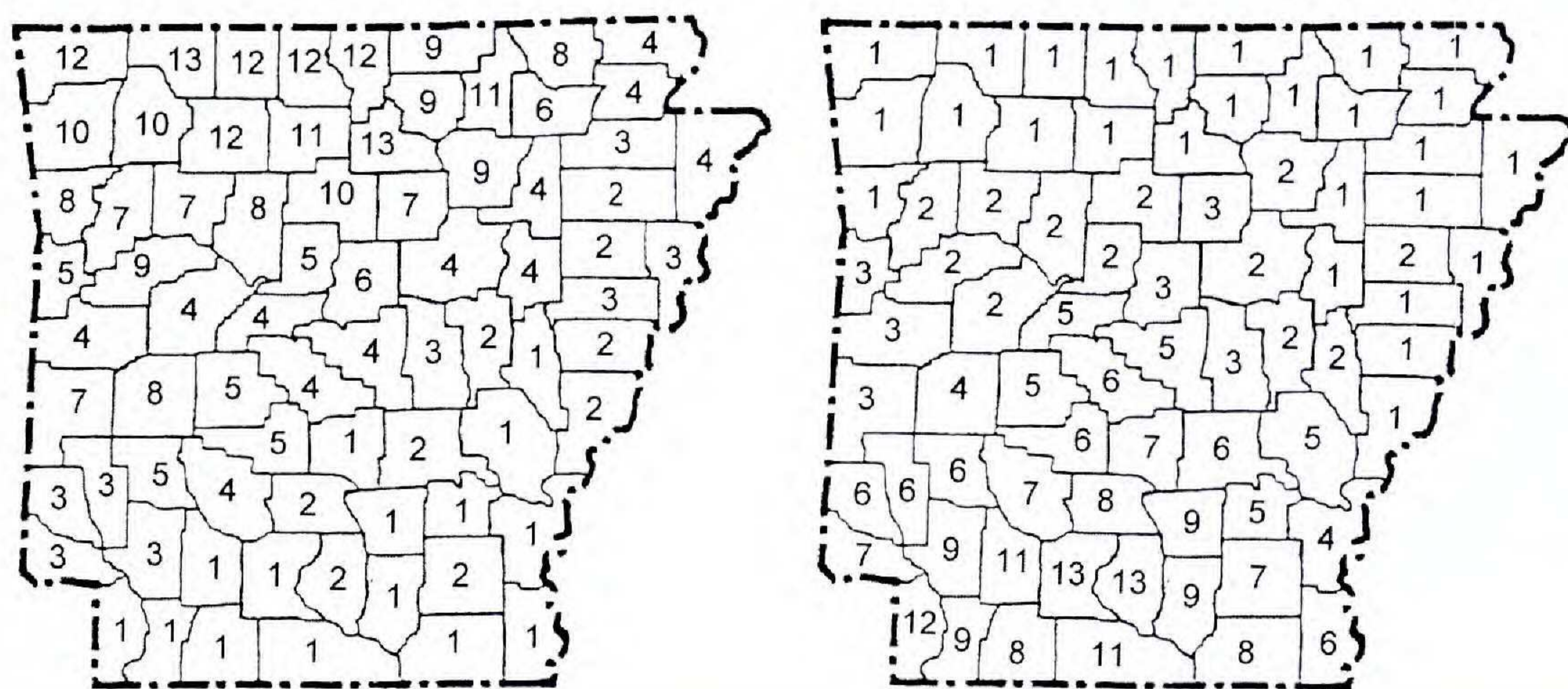


FIG. 3. Percent occurrence by counties of 227 Louisiana (left) and 272 Missouri (right) species (see text for further explanation).

Our analysis shows that the vast majority of plants occurring in north Louisiana and east Texas (West Gulf Coastal Plain) are also found in central and northern Arkansas. There is a gradual transition of species from the West Gulf Coastal Plain into the Interior Highlands and vice versa, and there are no marked or abrupt shifts correlated with the natural divisions of Arkansas, indicating that there are no major physiographical barriers. The only place we may have detected a possibly sharper transition is between the Ozarks and the Mississippi floodplain, but even here the transition is not precipitous.

The Interior Highlands are not floristically distinct from adjacent regions. The Ouachita flora as represented by Garland County, Arkansas, is closely related to the flora of all surrounding states especially Oklahoma, Louisiana, Mississippi, Tennessee, Kentucky, Alabama, Georgia, and the Carolinas (Fig. 4). The Ozark flora as represented by Newton County, Arkansas, is very similar to the Ouachita flora but, as would be expected, has a more northern affiliation. The Ozark region has its strongest floristic affinity with Oklahoma, Missouri, Illinois, Indiana, Kentucky, Tennessee, Ohio, Mississippi, Alabama, and Georgia (Fig. 4). If any generalization is necessary, the Interior Highlands as Zollner et al. (2005: 1788) have pointed out “shows surprisingly little floristic uniqueness from surrounding regions.”

Perhaps some or most of this lack of uniqueness is the result of movements of species north-south for the last two million years of 20 glaciations, with stragglers both north and south. This pattern of plant movement has been documented extensively, notably by pollen analysis but also by fossil plants (Givens & Givens 1987, Delcourt & Delcourt 2000). Also, edaphic conditions are not entirely dissimilar along this north-south continuum, with high rainfall and generally mild climates.

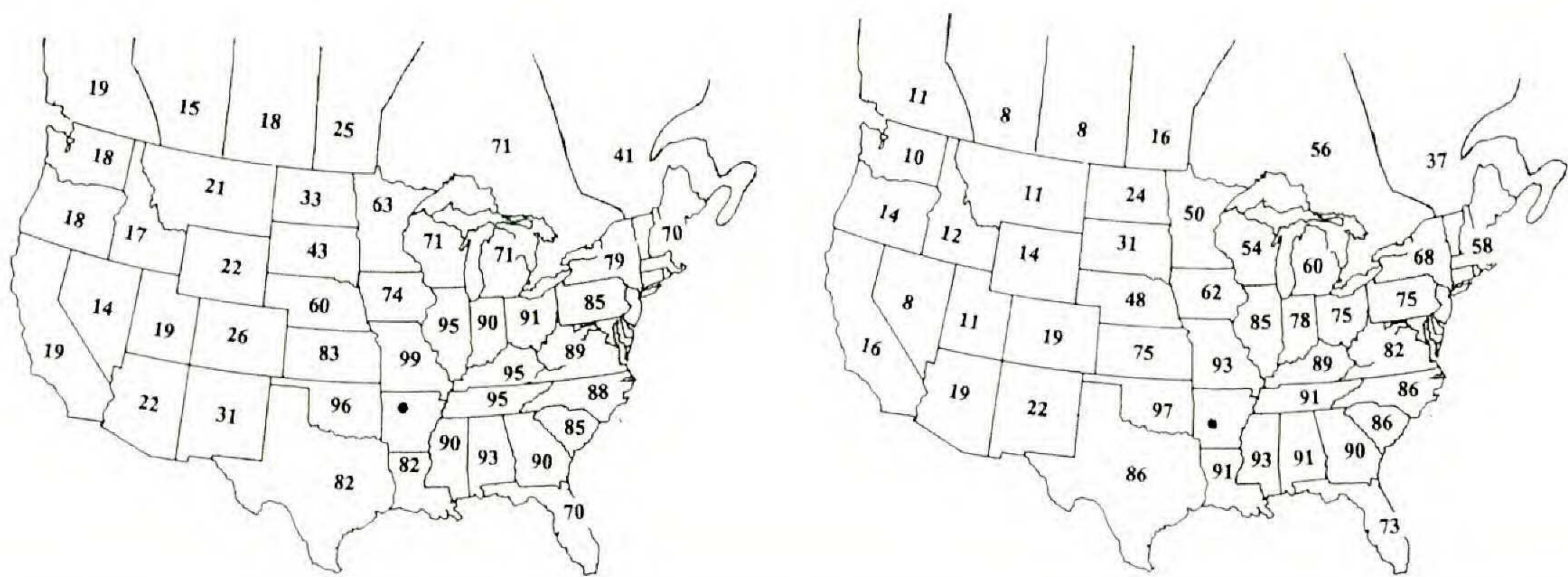


FIG. 4. North American floristic affinities of Newton County (left) and Garland County (right). Figures express percentage of species in common.

What these results mean for biogeographic classification and mapping is not entirely clear. Takhtajan (1986) has defined “province” differences as involving low levels of generic endemism and high levels of species endemism. “Ecoregion” is generally defined as a large area consisting of a distinct assemblage of natural communities and species with endemism being fairly high at the species and subspecies level (MacRoberts & MacRoberts 2004). The West Gulf Coastal Plain and the Atlantic and Gulf Coastal Plain have been the subject of recent endemic studies (Sorrie & Weakley 2001; MacRoberts et al. 2002). The West Gulf Coastal Plain has approximately 100 endemic taxa, three at the generic level. The Interior Highlands has only about 37 endemics, none at the generic level (Zollner et al. 2005). Setting aside the fact that no precise “index” has been proposed to test for provincial or ecoregional status, it seems from our analysis that the Interior Highlands and Gulf Coastal Plain are too similar floristically to be classified as different provinces or ecoregions. Perhaps some lower chorionomic category might better classify these two areas.

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